PATENT CLAIMS amended May 22, 2005. to WO 00/21244

1. (Currently amended) Packet switching data communications ~~networks (packet networks)~~ network with closed loop implicit feedback flow control **comprising** ~~Window-Time-Space Flow Control, WTFC, constructed using:~~

~~- WTFC terminals and~~

~~- nodes (201) with or without WTFC control algorithms~~

a Window-Time-Space Flow Control, WTFC, where a determined single server queuing system model with a finite number of packets and known value of a total network capacity point W_0,T_0 of a total network window W_0 , a total serving time T_0 and an aggregated propagation time T_p define a window - time plane of a packet window W and a delay time T, for determining

a hyperbola through said W_0,T_0 and a set of network response curves each for a fraction of total network capacity α, said hyperbola and said curves contained in said window – time plane, wherein each said response curve is determined with a break point lying on said hyperbola through W_0,T_0, and

a current W,T point measurement, wherein said window – time plane is used to determine whether said W,T point is positioned above or below said hyperbola, and to calculate optimal value of said capacity fraction α and said break point of the current response curve, wherein said break point is used to calculate an optimal window $W_0(\alpha)$, an optimal delay time $T_0(\alpha)$, and an optimal packet sending period $t'''(\alpha)$;

a terminal that uses said window - time plane and said W,T point measurement to obtain said optimal packet sending period and said optimal window, and is constructed using a packet receiver (113) and a packet transmitter (101) of packets or other data units;

a node (201) that uses a method to signal said total network capacity W_0,T_0 by updating a set of elementary network channel parameters in packet headers, wherein said network parameters are a cumulative propagation time T_{p0}, a cumulative reciprocal capacity and a minimal channel capacity C_b.

2. (Canceled)

3. (Currently amended) Network of Claim 1 wherein said packet ~~Packet~~ transmitter (101) ~~of Claim 2 that form packet in segmentation process (102) when user data exist and include in it's header acknowledgment data as ordered from the receiver, or form separate acknowledgment~~

~~packet as ordered from the receiver, store packet in packet buffer (104) and emit packet through packet sending process (105)~~ ~~**comprising**~~ **comprises** ~~initialization of header variables using~~

a header initialization process (103).

4. (Currently amended) Network of Claim 1 wherein said packet ~~Packet~~ transmitter (101) ~~of Claim 2~~ further ~~**comprising** the packet sending initiation~~ **comprises**:

~~-condition of packet sending period $t_0'''(\alpha)$ expiration (credit) in process of transmission rate clock signal with one credit buffer (108)~~

~~-condition of optimal window $W_0(\alpha)$ not being filled in process of optimal window check (111) that verifies whether current window is less than $W_0(\alpha)$~~

~~are satisfied.~~

an area check process (112) to check the position said measured point W,T relative to said hyperbola by inspecting a condition formula

$$(W-1)/(W_0-1) \geq T_0/\left((T-T_0)W_0+T_0\right),$$

a $W_0(\alpha)$ calculation process (110) to calculate said optimal window $W_0(\alpha)$ using

$W_0(\alpha) = T_p \cdot W/T + 1$ if said condition formula is satisfied and

$W_0(\alpha) = T_p/\left(T-T_p\right)+1$ if said condition formula is not satisfied,

a $t_0'''(\alpha)$ calculation process (107) to calculate said optimal packet sending period $t_0'''(\alpha)$ using

$t_0'(\alpha) = T/W_0(\alpha)$, $t_0''(\alpha) = t_0'(\alpha)(1+\gamma T_0)$ and

$$t_0'''(\alpha)_k = \begin{cases} \beta\, t_0'''(\alpha)_{k-1} + (1-\beta)t_0''(\alpha)_k \\ t_0''(\alpha) \end{cases}$$ wherein β and γ are filtering parameters.

5. (Currently amended) Network of Claim 1 wherein said packet ~~Packet~~ transmitter ~~(101) of Claim 2 further **comprising**~~: **performs**

~~-calculation of $t_0'''(\alpha)$ in $t_0'''(\alpha)$ calculation process (107)~~

~~-according to Equations 52 and 23, and 53 and 54~~

~~-calculation of $W_0(\alpha)$ in $W_0(\alpha)$ calculation process (110) using Equations 25 and 26~~

~~-check measured point (W,T) position in area check process (112) using Equation 18~~

a method to send a packet when two conditions are both satisfied: said optimal packet sending period $t'''(\alpha)$ expires and said optimal window $W_0(\alpha)$ is not filled,

a method to check said optimal packet sending period $t_0'''(\alpha)$ expiration in said $t_0'''(\alpha)$ calculation process (107) with a one credit buffer (108),

a method to check said optimal window $W_0(\alpha)$ not being filled in a process of window check (111) that verifies whether current window is less than $W_0(\alpha)$.

6. (Currently amended) Network of Claim 1 wherein said packet ~~Packet~~ transmitter (101) ~~of Claim 2 further~~ ~~**comprising**~~: **performs**

~~- parameters provided by receiver (113) after acknowledgment reception,~~

~~- (W,T) point measurement in (W,T) point measurement process (106)~~

~~- using Equations 1, 2 and 51~~

~~- calculation and correction of parameters (W_0,T_0) and T_p using total capacity~~

~~- estimation and correction process (109).~~

a method to use parameters provided by said packet receiver (113) after acknowledgment reception,

a W,T point measurement method inside a W,T point measurement process (106) using a transmission time of the packet k $t(P_k)$ and an acknowledgement time of the packet k $t(A_k)$ in formula $T = t(A_k) - t(P_k)$, and a last packet sequence number P_k and a last acknowledgment sequence number A_j in formula $W = P_k - A_j$ and using a window correction formula $W_k = (k-j)\left(t(A_k) - t(P_k)\right)/\left(t(A_k) - t(A_j)\right)$ to obtain corrected value for window W;

a method to calculate and correct said total network capacity point W_0,T_0 and said aggregated propagation time T_p inside a total capacity estimation and correction process (109).

7. (Currently amended) Network of Claim 1 wherein said packet ~~Packet~~ receiver (113) **comprises** ~~of Claim 2, that after packet reception with packet reception process (115) extract data with extraction process (114) and deliver them to users,~~ ~~**comprising**~~ ~~extraction of parameters from the packet header mentioned in Table 1 using extraction process (114), and delivering them to the transmitter (101).~~

an extraction process (114) adapted to extract said cumulative propagation time from a backward cumulative propagation time variable T_{p0b}, said cumulative reciprocal capacity from a backward cumulative reciprocal capacity variable S_{cib}, said minimal channel capacity from a backward minimal channel capacity variable C_{iminb}, said last acknowledgment sequence number from the packet header and said transmission time

from a backward transmission time variable $T(p_k)_b$ or from a local record, and to deliver said extracted parameters to the packet transmitter (101).

8. (Currently amended) Network of Claim 3 wherein header initialization ~~Initialization~~ process (103) ~~of Claim 2~~ ~~**comprising**~~ **performs** initialization of ~~new~~ packet header variables ~~mentioned in Table 1~~ by:

~~-setting the forward last acknowledgment variable a_{jf} to the value of last acknowledgment number received,~~

~~-setting backward last acknowledgment variable a_{jb} to the value of the same forward variable received in packet from the opposite direction, whose acknowledgment number is carried by new packet,~~

~~-setting forward sending time variable $T(p_k)_f$ to actual local time~~

~~-setting backward sending time variable $T(p_k)_b$ to the value of the same forward variable received in packet from the opposite direction, whose acknowledgment number is carried by new packet~~

a method to set a forward last acknowledgment variable a_{jf} to the value of said last acknowledgment sequence number received,

a method to set a backward last acknowledgment variable a_{jb} to the value of said forward last acknowledgment variable received in packet from the opposite direction, whose acknowledgment number is carried by a new packet,

a method to set a forward transmission time variable $T(p_k)_f$ to actual local time,

a method to set said backward transmission time variable $T(p_k)_b$ to the forward value of said transmission time variable received in packet from the opposite direction, whose acknowledgment number is carried by a new packet.

9. (Currently amended) Network of Claim 3 wherein header initialization ~~Initialization~~ process (103) ~~of Claim 3~~ further **performs** ~~**comprising**~~ initialization of ~~new packet header variables mentioned in Table 1 when total network capacity signaling method is used, by:~~ said packet header variables when said total network capacity signaling method is used, by using:

~~-setting forward propagation time cumulative variable T_{p0f} to zero.~~

~~-setting forward reciprocal capacity value cumulative variable S_{cif} to zero.~~

~~-setting forward reciprocal minimal channel capacity variable C_{iminf} to the maximal value~~

~~-copying values from variables T_{p0f}, S_{Cif}, i C_{iminf} received in the opposite direction packet to the same backward variables.~~

a method to set a forward cumulative propagation time variable T_{p0f} to zero;

a method to set a forward cumulative reciprocal capacity variable S_{cif} to zero;

a method to set a forward minimal channel capacity variable C_{iminf} to the maximal value;

a method to copy values from said forward variables T_{p0f}, S_{Cif}, ~~i~~ and C_{iminf} received in the opposite direction packet to said backward variables T_{p0b}, S_{Cib}, and C_{iminb} respectively.

10. (Currently amended) Network of Claim 5 wherein performing sending period in $t_0'''(\alpha)$ expiration **comprises** ~~clock calculation process (107) with one credit buffer (108) of Claim 4 **comprising** connection startup algorithm according to Figures 9 and 10 for smooth packet sending, and after expiration of period initialized~~:

~~-before first acknowledgment reception, and if there is no credit stored, increments credit buffer by 1 and reinitiates the same time period,~~

~~-before first acknowledgment reception, and if there is credit stored, initiates double time period and initiates packet emitting,~~

~~-after first acknowledgment reception sets credit buffer to 1 and initiates packet emitting.~~

a connection startup algorithm for smooth packet sending, that acts upon expiration of a time period initialized:

a first method of said startup algorithm used before first acknowledgment reception, and if there is no credit stored, said first method sets said credit buffer to 1 and reinitiates the same value of said time period,

a second method of said startup algorithm used before first acknowledgment reception, and if there is credit stored in said credit buffer, said second method initiates double value of said time period and initiates packet emitting,

a third method of said startup algorithm used after first acknowledgment reception, said third method sets said credit buffer to 1 and initiates packet emitting.

11. (Currently amended) Network of Claim 6 wherein said total ~~Total~~ capacity estimation and correction process (109) ~~of Claim 6 **comprising**~~ **performs**, when said total network capacity signaling method is used,

~~-calculation of T_p according to Equation 37,~~

~~-calculation of T_0 according to Equation 3,~~

~~-calculation of W_0 according to Equation 27,~~

~~applying extracted parameters from first or every packet received from the opposite direction.~~

a method to calculate said aggregated propagation time T_p by

$$T_p = \sum_i T_{pi} + \sum_i T_{si} - T_{sb} = T_{p0} + \overline{M}\left(\sum_i 1/C_i - 1/C_b\right)$$

where $\overline{M}$ stands for average packet length,

a method to calculate said total serving time T_0 by $T_0 = T_s + T_p$

where T_s stands for service time available from the said minimal channel capacity,

a method to calculate said total network window W_0 by $W_0 = T_0/T_s$,

a method to apply extracted parameters from first or every packet received from the opposite direction.

12. (Currently amended) Network of Claim 6 wherein said total ~~Total~~ capacity estimation and correction process (109) ~~of Claim 6~~ further ~~**comprising**~~ **performs**, when said total network capacity ~~estimation and packet pair methods are~~ signaling method is not used,

~~-calculation of T_0 using T_0=T after the first acknowledgment is received,~~

~~-calculation of W_0 using $W_0=T_0/(T-T_0)$ after the second acknowledgment is received~~

~~applying extracted parameters from every packet received from the opposite direction.~~

a method to calculate said total serving time T_0 using T_0=T after the first acknowledgment is received,

a method to calculate said total network window W_0 using $W_0=T_0/(T-T_0)$ after the second acknowledgment is received,

a method to apply extracted parameters from every packet received from the opposite direction.

13. (Currently amended) Network of Claim 5 wherein said total ~~Total~~ capacity estimation and correction process (109) ~~of Claim 6~~ further ~~**comprising**~~ **performs**, when said total network capacity ~~estimation and packet pair methods are~~ signaling method is not used, if measured $T<T_0$

~~-correction of T_0 using T_0=min(T),~~

~~-correction of W_0 using Equation 49 if $T<T_p$, otherwise using Equations 43 and 44,~~

~~-correction of T_p using Equation 17,~~

~~applying measured parameters from every packet received from the opposite direction.~~

a method to correct said total serving time T_0 using minimal measured value of said delay time T, T_0=min(T),

a method to correct said total network window W_0 using $W_0' = \max\left(\left(T_0'/T_0\right)W_0\ ,\ W\right)$ if $T<T_p$, otherwise using $W_0' = T_0'/\left(T_0' - T_p\right)$ and $W_0' = T_0'/T_s$, where W_0' and T_0' stand for corrected values,

a method to correct said aggregated propagation time T_p using $T_p = T_0\left(W_0 - 1\right)/W_0$,

a method to apply measured parameters from every packet received from the opposite direction.

14. (Currently amended) Network of Claim 1 wherein the node ~~Nodes~~ (201) ~~of Claim 1, Figure 2, that~~ is adapted to forward packets with forwarding process (202) and further **comprises**, ~~**comprising**,~~ when network capacity signaling method is used,

a capacity signaling process (203).

15. (Currently amended) Network of Claim 14 wherein said capacity ~~Capacity~~ signaling process (203) **performs** ~~of Claim 14 **comprising** the modification of first or every packet by~~
~~-updating forward propagation time cumulative variable T_{p0f} using Equation 33,~~
~~-updating forward reciprocal capacity value cumulative variable S_{cif} using Equation 34,~~
~~-updating forward reciprocal minimal channel capacity variable C_{iminf} using Equation 35~~

a method to update said forward cumulative propagation time variable T_{p0f} of first or every packet using $T_{p0} = \sum_i T_{pi}$,

a method to update said forward cumulative reciprocal capacity variable S_{cif} of first or every packet using $T_{s0} = \overline{M}\sum_i 1/C_i$,

a method to update said forward minimal channel capacity variable C_{iminf} of first or every packet using $C_b = \min_i\left(C_i\right)$.